3·2 mag. Two determinations of the parallax are given:

(1) 0·20″ ± 0·05″ M. Philippot.
(2) 0·06″ ± 0·07″ M. Delporte.

Both determinations appear to be improbably large, judging by the small proper motion and the values obtained for other novæ.

A. C. D. CROMMELIN.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.[1]

THE issue of the thirty-third annual report of the Liverpool Marine Biology Committee, and, as we are informed, the last of the series, is an opportune moment for the publication of a review of the important work that has been done since the formation of the committee in 1885. This report is not the swan-song of a dying enterprise, but rather the triumphant cry of those who have achieved an initial victory that gives hope for a rapid and continuous advance in the future; and, although the old L.M.B.C. ceases to exist, there is every reason to believe that its work will be carried on with increased efficiency by the newly organised staff of the oceanography department of the University of Liverpool.

In the short history of the work of the committee that is published in this report it is clear that a very substantial contribution has been made to our knowledge of the species of animals and plants that inhabit the waters of the Irish Sea, and that valuable information has also been acquired about the many characters of the sea-bottom round the Isle of Man and the north coast of Wales.

All this is necessary pioneer work, although much of it may seem dull and uninteresting when in print. The workmen must learn the use of their tools before undertaking the more serious work of production. But we see in the L.M.B.C. memoirs, of which twenty-three have already been published, in the important investigation of Prof. Herdman and his colleagues on the fluctuations of the plankton, and in the biochemical researches of Prof. Moore and others, that these valuable contributions to our scientific knowledge of the sea have outgrown the "Records" of the early years of the life of the committee.

The work of recording and describing the booty of the sea must, of course, continue; but with the ripe experience of thirty-three years, with the more complete equipment of laboratory space and apparatus, and with the new organisation of the oceanography department of the University, we may confidently look forward to further important developments in the general scientific work of the Port Erin institution.

We may tender to Prof. Herdman our cordial congratulations on his achievements in the past and our good wishes for the full success in the future of the great enterprise which is so largely due to his own personal genius and enthusiasm.

S. J. H.

APPLICATIONS OF INTERFEROMETRY.

IN a report by Prof. Carl Barus, of Brown University, recently published by the Carnegie Institution of Washington, a number of interesting applications of achromatic interferometry are described. In the first chapter a method of measuring small angles is discussed. The general theory of the subject is developed at some length, and a variety of interferometer devices, with mirror, ocular, and collimator micrometers, are instanced. As the achromatic fringes cannot (in general) be found without first finding the corresponding spectrum fringes, the second chapter is devoted to spectrum fringes. The work described in the third chapter was undertaken at the request of Prof. W. G. Cady, in the endeavour to obtain the elastic constants of small bodies. The application of the displacement method proved astonishingly easy in a case where a degree of rough handling is inevitable, but it was found that there lurked in the elastic apparatus some discrepancies, both of viscosity and hysteresis, the nature of which escaped detection after many attempts to locate its origin. The fourth chapter contains applications of the rectangular interferometer using achromatic fringes to the study of gravitation. A method for the determination of the Newtonian constant is worked out. Again, the same interferometer is associated with the horizontal pendulum for the detection of small changes in the inclination of the earth's surface. Series of observations extending between January and August are recorded. In the fifth and last chapter the author deals with the application of interferometers to the study of vibrating systems. To test the method, an examination is made of the vibration of telephonic apparatus. Interference-vibration curves have been obtained for two identical telephonic systems joined directly in series, while these forms subsided completely when the telephones were joined differentially.

RESEARCHES AT HIGH TEMPERATURES AND PRESSURES.

BY THE HON. SIR CHARLES A. PARSONS, K.C.B., F.R.S.[1]

I.

JUST ten years ago in this room Sir Richard Threlfall discussed the effects of temperature and pressure on various substances, and commenced by referring to a suggestion I made in 1904 to sink a bore-hole twelve miles deep in the earth with the object of exploring the region beneath us, about which so little is known. Last summer at Bournemouth I ventured again to direct attention to the desirability of such an exploration in the interests of science generally, and to the possibility that it might ultimately lead to some developments of practical importance and utility.

Ten years ago no experiments had been made on the behaviour of rocks under the conditions existing at great depths below the surface of the ground; but, prompted by my suggestion in 1904, and after some subsequent correspondence in regard to the possibility of the rock crushing in and closing the shaft, Prof. Frank D. Adams, of McGill University, Montreal, commenced experiments on the strength of rocks to resist the closing up of cavities under the conditions prevailing at great depths below the surface. He published the account of these experiments in the *Journal of Geology* for February, 1912.

Adams's method was to place a block of granite or limestone in a tightly fitting cylinder of nickel-steel, which was shrunk lightly around the block to ensure perfect fitting and support; hard steel rams actuated by a hydraulic press were arranged to exert a known pressure against the ends of the block. Two small holes were previously drilled in the specimen, one axial in the centre and one transverse, the diameter of the holes being 0·05 in., or one-tenth the diameter of the specimen. The temperature of the container and specimen was maintained at any desired point up to the softening point of steel. In some experiments no heat was applied, while in others the temperature was raised to that estimated to exist at the depth below the surface of the earth corresponding to this pressure.

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[1] The Marine Biological Station at Port Erin. Thirty-third Annual Report of the Liverpool Marine Biology Committee. Drawn up by Prof. W. A. Herdman. Pp. 84. (Liverpool: C. Tingling and Co., 1919.)

[1] Discourse delivered at the Royal Institution on Friday, January 23.

When no heat was applied the holes in the granite showed no alteration under a pressure equivalent to thirty miles deep, and in the case of limestone the specimen supported one-half of this pressure without alteration. Adams then raised the temperature of the container and specimen. When granite was heated to 550° C., a temperature corresponding to eleven miles below the surface, it stood a pressure equivalent to fifteen miles, and might have stood more but that the container became weakened by the heat. Limestone begins to decompose at a temperature of 450° C., but even at this temperature it withstood a pressure corresponding to ten miles.

Adams concludes that small cavities in granite will not close in under the conditions of pressure and temperature at eleven miles below the surface, however long a time is allowed to lapse, and that the cavities may persist to much greater depths, but the softening of the steel of the container precluded the carrying of his experiments to still higher temperatures and pressures.

So far as they go, these experiments are reassuring as to the permanence and safety of a pit shaft twelve miles deep sunk through granite, but it would be more satisfactory to experiment on a larger specimen than one only ½ in. in diameter as used by Adams, and to heat the specimen electrically when submerged in graphite while keeping the container cold, the temperature being indicated by a thermo-couple in the specimen. This could be carried out in a nickel-steel container like that shown in Fig. 2.

In this connection P. W. Bridgeman in 1911 submerged a sealed glass tube containing a cavity under an external hydrostatic pressure of 24,000 atmospheres (corresponding to a depth in the earth of fifty-six miles) for three hours, and the cavity showed no change in size or form. It, however, appears that temperature will probably place a limit to the depth that could be reached before the closing in of the shaft commences to occur, for Judd, Milne, and Mallet agree in the view that the deepest origin of earthquakes is between thirty and fifty miles. This would seem to indicate that at greater depths than thirty miles the temperature and pressure are such that changes of form take place by plastic deformation, and not by sudden slips or the formation of faults, which are the chief cause of earthquakes. Again, Oldham states that beyond twenty miles deep seismic waves which are transmitted by compression and distortional vibrations change in character in this respect: that though the compressional waves are only slightly affected in velocity, on the other hand the distortional waves are reduced to one-half their velocity. This would seem to imply that the modulus of elasticity in shear has, at twenty miles depth, owing to the rise of temperature, fallen to one-half, and it seems probable that the rock also is weakening in its resistance to shear; in fact, that the rock is becoming more plastic, and that cavities would probably close up at twenty miles below the surface.

The greatest depth to which a shaft has as yet been sunk is only about 1⅕ miles. The deepest single-stage shaft on the Rand is that of the Hercules East Rand Proprietary Mine. It is 4500 ft. vertically, and rectangular in section. The deepest shaft in the world is that at Morro Velho, Brazil. The bottom is 6400 ft. vertically below the surface, and it has been sunk, and is worked, in stages, two of which are about 1200 ft. vertical. The deepest shaft designed on the Rand is by the City Deep Co. It is 7000 ft. vertically, is circular of 20 ft. diameter, and is to be worked in two stages of 3500 ft. each. The most rapid sinking record was made at the Crown Mines No. 15 Shaft, where 310 ft. were sunk in a month; the shaft is circular, and of 20 ft. in diameter.

There are several interesting departures from ordinary mining practice necessary. The haulage is arranged in stages of about half a mile, principally in order to economise the weight of rope and also the power for winding. In countries where the atmosphere is dry the sides of the shaft are cooled by sprinkling water upon them, which by evaporation cools the rock. It is, however, possible to augment this effect by artificially drying and cooling the air before passing it down the mine.

When still greater depths of shaft are in contemplation further methods of cooling in addition to these would probably be found necessary; for instance, the carrying of the heat upwards by means of brine circulated in a closed ring formed of steel pipes with a rising and descending column. Though the columns might be carried the whole depth of twelve miles, the hydraulic pressure at the bottom would be about 12 tons per square inch, and entail very costly pipes of great strength to resist the pressure. A cheaper plan would be to work in stages, each ring covering a stage of from two to three miles of the shaft, the heat being transferred from the top of one brine ring to the bottom of the ring above by surface-heat exchangers and refrigerating machinery to neutralise the heat drop on transfer. These may be called heat pumps, and would be driven electrically.

As the depth of the shaft increases, the pressure of the air upon the miners will be about doubled for every three miles, but what is more serious is the increase in temperature of the air itself caused by the adiabatic compression due to gravity, by which it will be raised about 100° F. For these reasons it will be necessary to place airtight partitions across the shaft at every mile or two, and to carry on the ventilation through these by means of a pump to deliver the foul air upwards and an expander to allow the fresh air to descend. These two machines would be linked together, and the difference in their power supplied by an electric motor. (This method has been often used with water, and is equally applicable to air.)

At each partition heat exchangers and refrigerating machinery similar to those used for the brine would be placed. Another and preferable plan would be to place numerous heat exchangers between the ascending columns of air to transfer heat from one to the other. The air would, in this case, not itself act as a conveyor of heat to the surface, for which the brine columns would be depended upon, but it would enable airlocks every three miles to suffice. A further alternative and very simple method would be to convey liquid air from the surface, and allow it to escape at the part of the shaft requiring cooling. It would ensure good ventilation.

When sinking the deeper portions of the shaft, shields would probably be necessary to protect the miners from the splintering of the rock which is caused by the intense compressive stress, which splits off scales from the surface, sometimes with considerable violence.

In 1904 the estimate of the time required to sink twelve miles was eighty years, and was based on the records of that time. With improved machinery and methods the records have been so much lowered that an estimate of thirty years seems now to be reasonable.

Threlfall traced the gradual evolution of the theory of the effects of temperature and pressure on the allotropic forms of various substances. He described his apparatus and experiments designed to melt graphite under high pressure, his inference then being that under pressures up to 100 tons per square inch carbon does not follow the same law as many other substances, and does not crystallise as diamond on cooling.

An interesting discovery was made by Bridgeman in 1911 when studying the compressibility of mercury. He found that it had a remarkable power of penetrating steel containers, a power not possessed by oil or water, which caused them to burst at much lower pressures than when they were charged with oil or water. The phenomenon he attributed to the fact that mercury has the power of dissolving small percentages of iron, and will amalgamate with it when the surfaces are absolutely free from oxide.

In 1912 Bridgeman published his remarkable researches on water under pressures up to 20,000 atmospheres. He found that there are four allotropic forms of ice besides ordinary ice, which are found under various conditions of pressure and temperature with determinate regions of stability. All these forms except ordinary ice are more dense than water; one is remarkable as existing from a temperature of −18° C. under a pressure of 4500 atmospheres up to a temperature of 67° C. under a pressure of 20,000 atmospheres.

Recently a pressure of from 200 to 1000 atmospheres at a temperature between 500° and 700° C. has been applied to compel hydrogen to combine with nitrogen to form ammonia on a great commercial scale, a catalyst being necessary to promote the combination and to establish the equilibrium between the gases and their product. This action is reversible as regards temperature and pressure. On the other hand, iron just molten is an energetic catalyst in the transformation of diamond into graphite, but, contrary to expectations, as we shall see, no amount of pressure that has yet been applied appears to have caused a reversal of this action.

More than thirty years ago, having suitable apparatus at hand, I made a few experiments to try the effect of high pressures and temperatures on carbon, compounds of carbon, and some other substances.

The apparatus consisted of an 80-ton press, under which suitable containers were placed, and a turbo-generator of 24 kilowatts output at 80 volts provided the current. It had been discovered by Cheesborough that the carbon filaments for incandescent lamps became very hard and resilient when heated in a hydrocarbon atmosphere of about 4 mm. absolute pressure, and I was anxious to try what would be the result if a rod of carbon were electrically heated when submerged in a liquid hydrocarbon under high pressure. Benzine, paraffin, treacle, chloride, and bisulphide of carbon were tested under a pressure of 2200 atmospheres, or about 15 tons per square inch. The results were not successful in producing a hard coating to the rod or in increasing materially its density and hardness except in the case of tetrachloride of carbon, which slightly consolidated and hardened it; on the contrary, the carbon deposited from the liquids always appeared as soft amorphous carbon like soot. These experiments were extended by substituting, instead of the liquids mentioned, silica, alumina, and other substances and increasing the pressure to 30 tons per square inch. When the current density was sufficiently increased the rod was converted to soft graphite. Moissan in 1903 expressed the view that iron in a pasty condition was the matrix of the diamond, and that great pressure was the determining factor, which compelled a minute fraction of the carbon present to appear as diamond; he further referred to the probability of carbon being liquefied when under a pressure sufficient to prevent its volatilisation, and that from the liquid state it may pass into the crystalline form on cooling. Crookes, in his lecture delivered before the British Association at Kimberley in 1905, emphasised the same view as to the probability of the crystallisation of carbon directly from the molten state on cooling.

Though my original experiments in 1888 were not favourable to these views, it nevertheless seemed desirable to carry the investigations up to the greatest possible pressures attainable. Experiments were, consequently, resumed in 1907 with a new equipment, which consisted of a 2000-ton hydraulic press and a storage battery of 360 kilowatts output. The battery can be coupled for 2, 4, 8, 16, or 48 volts as required, and the mains and the main switch can carry currents up to 80,000 amperes to the hydraulic press, which is placed by itself in a small, strong house partly below ground, with walls of 2 ft. thickness reinforced with steel bars; the door is of steel 3 in. thick, and the roof is of light galvanised iron. The container under the press is further enclosed by 2 in. thick telescoping steel rings, raised into position by steel ropes and counter-weights. These precautions, as experience showed, were necessary, as several violent explosions occurred which cracked the steel rings and blew off the roof. A charge of iron and carbon, when confined and raised to a high temperature, may be very violent if suddenly released by the melting of the pole-pieces; also some endothermic compounds have been formed which swelled the container and allowed the contents to escape.

My experiments confirmed the conclusion at which Threlfall had independently arrived: that under pressures up to 100 tons per square inch and very intense heating by electrical current, graphite is not materially changed. But modifications in the experiments were made and other methods adopted, as will be explained, which in some respects carried the investigation to still higher pressures and temperatures; these, however, lead to the same conclusion.

I propose this evening to deal chiefly with the practical or engineering side of the subject, and to review the limits of pressure and temperature which are artificially attainable, and to make some comparison between them and the pressures and temperatures occurring in Nature.

When the blade of a knife is pressed strongly against another blade so as to make a dent in each, the pressure on the boundary surface of the metal at the notch will have averaged from 300 to 350 tons per square inch, according to the hardness of temper of the steel. The pressures on the knife-edges of a weighing machine when fully loaded are also of the same order.

When a needle is broken or a piece of piano-wire is strained to the point of breaking, the maximum tension on the metal will be at the rate of 150 tons per square inch. On the other hand, the pressures that occur in the chambers of large guns do not usually exceed 20 tons per square inch, and the tensile stress on the plates of a ship in heavy weather should not exceed 8 tons per square inch. From these simple instances some idea is gathered of the limitations imposed by materials and dimensions upon apparatus for experimenting at high pressures because of the practical difficulty of hardening and tempering steel in large masses.

When dealing with small amounts of material in each experiment the dimensions allow of the container and the ram being made of tungsten steel, which can be hardened and tempered throughout, and not only superficially, as in the case of ordinary carbon steel.

The material is hard and strong, but not brittle, and it retains these qualities up to moderate temperatures, such as 600° C., to a much greater extent than any other steel.

In one form of container or die the bore is $1\frac{1}{2}$ in. in diameter, and it may be used for a limited number of times for a pressure of 200 tons per square inch. It will, however, eventually crack if this pressure is many times repeated, the cracks usually beginning near the bottom of the die.

For still higher pressures it is better to use a double re-entrant container with two rams $\frac{1}{2}$ in. in diameter. Both the container and the rams are made of hardened and tempered tungsten steel, and are rendered fluid and gastight by mild steel cups on the ends of the rams.

If the charge occupies only a short length of the bore, as shown, the barrel of the container where the charge lies is supported by the shear strength of the metal above and below the zone of pressure in addition to its own strength as a tube. Under these conditions it is as strong as or stronger than the crushing strength of the rams, and pressures of 300 tons per square inch may be repeated several times without cracking.

In a container of this form seven grains of fulminate of mercury have been placed, embedded in graphite, and the pressure increased very gradually until it reached 230 tons per square inch (under this treatment fulminate does not usually detonate). The die was then heated by gas to more than 180° C., the temperature of detonation. After two failures of the experiment, owing to the leakage of the steel cups, the third was successful, and no gas escaped and the container was uninjured. The graphite was somewhat caked, but otherwise unaltered. Graphite mixed with sodium nitrate and fulminate was also exploded under the same conditions. Graphite with 15 per cent. of potassium chlorate detonated when 200 tons per square inch had been reached.

Many other reactions were tested in a similar manner in larger dies under pressures of from 40 to 200 tons. The action of concentrated sulphuric acid on sugar was accelerated by a pressure of 50 tons, but, on the whole, these experiments in dies failed to produce any interesting results.

Unfortunately, the heating of the die with its charge cannot be carried much above 500° C. without serious weakening of the steel and compelling a reduction of pressure. The electrical heating of the charge in such small dies, while keeping the die cool, presents great difficulties in electrical insulation on so small a scale to withstand intense pressure, but I think that it might be accomplished in certain instances.

It has been suggested, with the object of reaching higher pressures, that a small die might be bodily immersed in a large container. Doubtless it could be arranged, but it would be very cumbersome to work with, and would only add about 100 tons per square inch to the maximum pressure.

A better plan would be to follow the principle of the usual capped armour-piercing projectile, and to reinforce the rams and ends of the container by tightly fitting copper or bronze rings around the necks of the rams, keeping the parallel part of the noses as short as possible.

When in operation the copper rings will be flattened and squeezed against the necks and shoulders of the rams, and also against the ends of the container, and by this means the parts that ordinarily would have to bear the maximum stress will have part of this stress transferred to other parts not so heavily stressed, and, consequently, the maximum pressure in the container can by this means be raised considerably, perhaps to 450 tons per square inch.

In carrying out experiments on larger samples of material and in applying electrical heating to the charge, the container becomes too large to permit of its being made of hardened steel; therefore, nickel-steel is used, as for the barrels of guns. It is heat-treated by quenching in oil from a high temperature after rough machining. Containers (Figs. 1 and 2) with the thickness of wall equal to the diameter of the bore will stand an internal pressure of 40 tons per square inch repeated almost indefinitely without serious enlargement of the bore, but 100 tons necessitates reboring and the fitting of new packing to the ram after each experiment.

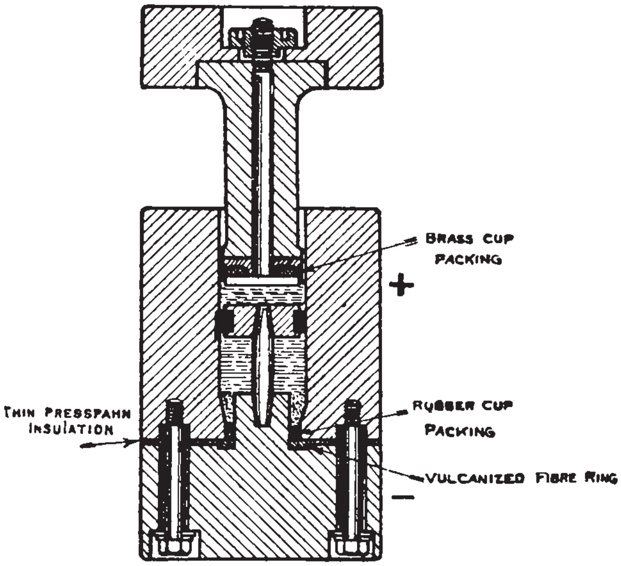

FIG. 1.—Chiefly for liquids.

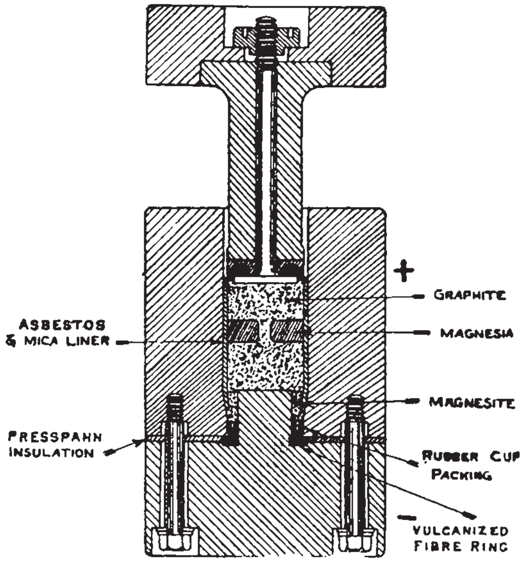

FIG 2.—For melting carbon.

Fig. 1 shows the arrangement for electrically heating conductors immersed in fluids under high pressure. The packing of the ram is a cup leather-backed by a cup of brass; the leather first takes the pressure, and the lip of the brass cup is thereby expanded tightly against the bore of the container, and remains fluid-tight even though the leather should be carbonised by the heat. The bottom pole is electrically insulated from the container by vulcanised fibre washers and a rubber cup-ring, which is protected from the heat by magnesite stemming.

The current is conveyed from the container to the top pole-piece of the conductor by pads of copper gauze, which can slide easily against the bore of the container and allow for the expansion of the conductor. Experiments on liquids with this container under 4400 atmospheres gave the same results as my former experiments under 2200 atmospheres.

Fig. 2 shows the container arranged to melt graphite under pressure by resistance heating. Here the charge is graphite, and is divided by the bridge or ring made of pressed calcined magnesia or of titanium oxide. The bore of the container is electrically insulated from the graphite by layers of asbestos, millboard, and mica.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice has been given that there will be an examination for the recently instituted diploma in psychological medicine: Part i. next October, part ii. next December.

OXFORD.—On Tuesday, February 17, the preamble of a statute providing that women may be matriculated and admitted to degrees in the University passed Congregation without a division.

The report recently issued of the Committee for Rural Economy shows a large increase in the number of students. The Michaelmas term began with 200 students, of whom 123 were working at agriculture and 77 at forestry. Lectures have been given on various subjects connected with agriculture, including courses on forest and agricultural botany, live-stock, principles of cultivation, soils and manures, together with the history of agriculture and agricultural economics. Practical laboratory work has been provided, and classes have been held at the University farm.

A vote will be taken in Convocation on the question of Greek in Responsions on Tuesday, March 2. No further amendment being now possible, the statute will have to be passed or rejected as it now stands. Many will regret that the chance of an agreed statute was lost by the opposition of those who objected to the retention of the Greek language as a preliminary requirement even for the final literary and classical examinations. The defenders of Greek were willing to grant exemption to all students of natural science or mathematics, as well as to all passmen, but this concession failed to satisfy their opponents.

A COURSE of three free public lectures on Fermat's last theorem will be given by Mr. L. J. Mordell at the Birkbeck College on March 10, 17, and 24 at 5 o'clock. Tickets of admission are obtainable from the secretary of the college.

THE annual meeting of the Association of Technical Institutions will be held on Friday and Saturday, February 27 and 28, at the Cordwainers' Hall, London, E.C. The proceedings will commence at 10.30 on the Friday morning, when the president-elect, the Marquess of Crewe, will deliver his presidential address. Resolutions will be submitted dealing with pensions and salaries for teachers in technical institutions, and papers will be read by Mr. A. Mansbridge on Technical Schools and their Part in relation to Adult Education, Dr. R. S. Clay on Scholarships, and Mr. H. J. Taylor on Day Continuation Schools.

THE following scholarships will be offered for competition by the Institution of Naval Architects this year:—*Naval Architecture:* Vickers (150*l.* per annum), Hawthorn Leslie (150*l.* per annum), John Samuel White (100*l.* per annum), and Denny (75*l.* per annum). *Marine Engineering:* R. L. Scott (150*l.* per annum) and Denny (75*l.* per annum). These scholarships are open to British apprentices or students, and are tenable (subject to the regulations governing each scholarship) for three years at one or all of the following educational establishments:—Glasgow University, Durham University (Armstrong College), Liverpool University, Royal Naval College (Greenwich), and City and Guilds (Engineering) College (London). Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

AN inaugural lecture on "The Universities and the Training of Teachers," delivered at Oxford last October by Mr. F. J. R. Hendy, the Director of Training in the University, has been published by the Clarendon Press in pamphlet form. Mr. Hendy deals briefly with the conditions of the new Education Act and the qualities which will be required for those who are to carry out its provisions for senior elementary, secondary, and continuation schools. In particular, he dwells on the necessity for teachers of a wider and less specialised knowledge, men and women who can take all but the highest work in two, or even three, kindred subjects. The valuable influence of the form-master is something which has tended to disappear from secondary education in recent years, and it should be one of the duties of the training colleges to restore it, at the same time avoiding the danger of superficiality by dividing the subjects of study vertically rather than horizontally, so that, instead of going half-way in two or three honours subjects, a student should go the whole way in a section of each. Some suggestive remarks are made on the subjects of method and psychology, words frequently used, but often misused; also on the immense growth of the administrative side of educational work and the comparatively small expansion of the professional or teaching side. The University Press has done a good service in putting this lecture within the reach of all concerned with the supply of men and women for the teaching profession.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, February 4.—Mr. G. W. Lamplugh, president, in the chair.—J. A. **Douglas:** Geological sections through the Andes of Peru and Bolivia: ii., from the Port of Mollendo to the Inambari River. The paper gives a description of a geological section across the Andes of southern Peru, from the port of Mollendo to the Inambari River, a tributary of the Madre de Dios. The deflection of the Pacific coast-line of South America north of Arica towards the north-west brings to light a zone of ancient granite and gneiss comparable with the rocks of the coastal Cordillera of Chile. These rocks are shown to be of "alkaline" type, and are contrasted with the "calcic" granodiorites forming the batholitic core of the western Cordillera. It is suggested that their formation preceded the uplift of the folded chains. The Jurassic zone of northern Chile has been almost entirely stripped from the underlying plutonic core, but its continuation has been proved at more